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AN EVALUATION OF TREE HAZARD AT QUAKER MEADOW CAMP,
TULE RIVER RANGER DISTRICT, SEQUOIA NATIONAL FOREST

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ABSTRACT

Quaker Meadow Camp is situated in an old-growth true fir stand on the Western Divide near Quaking Aspen. Tree failures in December 1982 caused considerable property damage, prompting the Tule River District to request a tree hazard survey of the Camp. The survey revealed several hazardous trees, as well as other tree defects and pest conditions that may affect management of the site. Management alternatives include no action, hazard tree removal, a systematic tree hazard evaluation program, and vegetation management. To ensure the greatest level of safety to the public, we recommend that the District implement all three action alternatives.

At the request of the Tule River District Ranger, I visited the District in July 1984 to evaluate tree hazard and pest conditions at Quaker Meadow Camp, which is two miles from Quaking Aspen on the Western Divide. The Camp is built on public land leased from the Forest Service, and is owned and operated by the California Yearly Meeting of the Friends Church of Whittier, California.

District Resource Officer Chic Spann oriented me to the site on July 9, and I completed a survey of the Camp area on July 10. Camp Manager Dennis Triaziac was very helpful in answering my questions. Over the last several years a number of large, old-growth firs have fallen during the winter, and one building was destroyed and another damaged during a storm in December 1982. Both the Forest Service and Camp management are concerned about preventing further property damage and possible injury. They requested that I survey the stands within the camp for pest conditions that might cause trees to be or become hazardous.

OBSERVATIONS

Quaker Meadow Camp is situated at 7200 feet elevation in a wet basin at the headwaters of the South Fork of the Middle Fork of the Tule River. The exposure is north to northeast. Conifer stands in this vicinity are composed of mixed red and white fir, with large, old-growth firs dominating the Camp. The poor condition of many of the tree crowns, the numerous stand openings, and the many large stumps indicate that the stand is decadent and has begun to break apart from old age, stem, butt, and root decay, and other pest-related causes. Building and road construction created wounds that hastened the decay and death of some trees, but did not cause the stand's decline. The major problem is that the Camp was built in a forest stand that, because of advanced age, is neither vigorous nor healthy.

I recorded all trees, snags, and stumps that were hazardous, had indicators of potential hazard, or were diseased. The survey results are illustrated in Figures 1 and 2 (pages 11-12) and are described in the accompanying key (pages 13-16). The following describes the main tree hazards, common tree defects, associated pest organisms, and two minor pest conditions.

HAZARD TREES

I rated six trees (map nos. 9, 15, 21, 25, 34, and 42) as hazardous, and one tree (map no. 19) as marginally hazardous. These trees should receive first priority for removal. I used a seven-point tree hazard rating system that was developed for use in Sequoia and Kings Canyon National Parks; this system is essentially similar to one developed in British Columbia (Wallis et al. 1980).

The system rates two elements on a scale of 1-3: failure potential, or the likelihood that a tree or tree part will fail, based on the presence of visible defects or defect indicators; and failure impact, or the consequences of tree failure, based on the size of the tree or tree part, the likelihood that it will hit the target if it fails, and the value of the target. To obtain the hazard rating, the scores for the two elements are summed and an additional point added if a tree leans severely. Generally, trees with ratings of 5 or greater are given top priority for removal, and those rated 4 are marked for periodic re-examination.

In all cases failure impact was rated 2 or 3 because of the closeness of trees to buildings. In fact, because of their size, most trees in the camp area are within impact range of one or more structures or play facilities and would receive a high failure impact rating. To aid in assessing the potential for future hazard, I have marked on the maps most trees that are 30 inches dbh or larger. The tree defects that contributed to the hazard ratings are described in the key on pages 13-16, and are discussed in the next section. Further information about how these defects increase failure potential may be found in Wagener (1963).

TREE DEFECTS AND DISEASE PESTS

Several tree defects and disease conditions were noted that either were responsible for current hazard conditions or could cause trees to become hazardous in the future. Note that trees with two or more defects may be hazardous even when the individual defects might not be serious by themselves.

Hanging dead branches. Several firs had large dead branches in their crowns (map nos. 3, 6, 12, 13, 31, 41, 43, 45, 49, 50, and 53). Although most dead branches fall during windstorms, others that are rotted at the base or merely lodged in the crown may fall at any time. Even small branches can cause injury, particularly if they fall from a great height into confined areas where children are playing (see map no. 45).

Leaning Trees. Ten trees had noticeable leans (map nos. 13, 14, 20, 32-34, 40, 42, 44, and 49). Trees that develop with leans are generally not hazardous because they form structural compensations as they grow. However, all trees that lean toward structures or play facilities should be marked and observed to detect any changes in the amount of lean, or any lifting and cracking of the ground around the base. And, leaning trees that have other defects or are growing in or near root disease centers are potentially hazardous.

Basal and Lower Stem Defects. Seven trees had visible stem defects such as scars, open wounds, or conspicuous bulges that suggest the possibility of internal decay (map nos. 9, 11, 15, 19, 23, 25, and 27). Generally, trees with a central column of decay can lose up to 70 percent of the total wood diameter inside the bark -- equivalent to a one-third loss in strength -- without being hazardous (see pages 3-4 and 24-25 in Wagener, 1963). I bored six trees at several points around the stem and found only one (map no. 25) with outer sound wood that was below the minimum safe standard. It should be noted, however, that any wound or opening into the cylinder will greatly reduce a tree's strength even if the width of the outer sound wood exceeds the standard.

Indian Paint Fungus Conks on Stem. Two trees had conks of Echinodontium tinctorium (map nos. 21 and 42). Slow-growing trees with large conks separated by ten feet or more usually have extensive decay and are potentially hazardous.

Dead or Broken Tops and Forks. Seven trees had this defect (map nos. 3, 12, 17, 22, 24, 26, and 39). Dead tops of firs are frequently decayed, and broken forks may become entry points for decay in otherwise live stems.

Forked Tops or Multiple Stems. Eight trees exhibited this condition (map nos. 5, 9, 17, 23, 26, 37, 42, and 50). Tight forks and large volunteer stems are potentially hazardous, particularly if they are aligned at a right angle to the heaviest winds.

Root Rot. I found Fomes annosus root decay in nine fir stumps (map nos. 7, 8, 18, 25, 29, 30, 34, and 51). I found Armillaria mellea alone in one fir stump (map no. 14), and with F. annosus in another (map no. 18);

because *Armillaria* and annosus decay are frequently associated in true firs, I suspect that *F. annosus* may also have been present in the stump where only *Armillaria* was found. Wherever annosus conks are found in fir stumps, adjacent old-growth firs with declining crowns, basal wounds, or a combination of defects may have extensive root decay. Unlike pines, true firs are usually not killed by *F. annosus*; instead, the fungus decays their roots and causes butt rot, often leading to windthrow during storms.

Sparse Crowns. Nine firs had notably thin crowns (map nos. 15, 16, 24, 28, 36, 39, 41, 43, and 49). Although not a direct hazard indicator, a poor crown may be the result of extensive root decay that can lead to windthrow.

Snags. Three snags are marked on the maps (nos. 1, 2, and 47). All snags and dead trees are potentially hazardous and should be removed.

Other Pest Conditions. Dwarf mistletoes (*Arceuthobium abietinum* f. sp. *magnificae* and *A. abietinum* f. sp. *concoloris*) were found on both red and white firs (map nos. 38, 39, 41, 42, 48, and 54). They are not primary causes of hazard, but can contribute to hazard by killing branches, creating bole swellings that are subject to decay, or reducing tree vigor so greatly that a fir cannot compensate with new root growth to replace roots lost to annosus decay. Yellow witches' broom (caused by *Melampsorella caryophyllacearum*) was also found at several sites (map nos. 38, 46, and 54), but is not a factor in hazard assessment. The main importance of these parasites is in planning replacement vegetation for openings in the stand caused by tree failures, root disease, and hazard tree removals. As noted earlier, the stand is declining, and some thought must be given to its replacement.

MANAGEMENT ALTERNATIVES

TAKE NO ACTION

If no action is taken, firs will continue to fail periodically. Most tree failures will occur during winter storms, but some firs will fail on calm spring, summer, or fall days. Over the next several decades property damage may be extensive, and there will be an increased risk of personal injury. Damage claims may be lodged against both the Camp owners and the Forest Service, and settlement will be time-consuming and expensive because of the failure of the concerned parties to treat identifiably hazardous trees.

TREAT TREE HAZARDS

Treating the hazard trees described in this report will reduce the risk of failure, property damage, and injury. First priority for treatment are the trees rated highest hazard (map nos. 9, 15, 21, 25, 34, and 42), snags and dead trees (map nos. 1, 2, and 47), and any trees that may have become hazardous during the last winter. Second priority are large, dead, loosely-attached, hanging or lodged branches (map nos. 3,

6, 12, 13, 31, 41, 43, 45, 49, 50, and 53, with particular attention to no. 45 because of its proximity to the enclosed children's play area), and the tree rated a marginal hazard (map no. 19). Third priority for treatment are other trees described here with single defects that were not hazard-rated; most of these trees will not need to be removed, but should be examined both to determine whether they developed new defects over winter that render them hazardous, and to gain familiarity with the defects and pests affecting them.

Hazard tree treatment will reduce the risk of failure, but will not eliminate it. Living beneath a canopy of large, old-growth trees has inherent risks that must be understood. Furthermore, all trees have some hazard potential, and no site can be made completely safe; some trees will have defects that are not visible, while others without serious defects may fail in a severe storm. In some cases, the dollar and esthetic costs of extensive tree removal may be prohibitive, and removal of structures or relocation of play facilities may be the only alternative to treating hazard trees. For a good discussion of tree hazard in relation to control costs, see Paine (1971).

Regional policy requires that all conifer stumps in recreation areas be treated with borax according to label instructions (see FSM 2305 and 2331.33, R-5 Supplement No. 90). Use of this pesticide will reduce the numbers of new annosus root disease centers, but will not suppress infection in stumps or centers where the root disease is already present.

INSTITUTE A TREE HAZARD EVALUATION PROGRAM

Beyond treating immediately hazardous trees, recreation managers should develop a plan for periodically evaluating Quaker Camp for future hazard. A systematic tree hazard evaluation program should include the following four elements:

Regular Inspection. Tree hazard evaluation must be done on a regular schedule, preferably once a year in the spring, and no less often than once every two years.

Records of Hazard Ratings. Inspectors should keep written records of tree species and size, defects, pests, hazard rating, and control decision for each tree evaluated; tag the trees that are to be monitored or removed (hazard ratings of 4 or greater); and map the trees in relation to structures if possible. Written records will make it possible for new inspectors to evaluate sites without having to start from scratch.

Records of Tree Failures. Recording tree failures, their causes, and associated damage will enable recreation managers to develop a history of the types of failures peculiar to their site, and help them evaluate future failure potential. Failure records also provide a check on the effectiveness of hazard tree removal guidelines; repeated failures may indicate that trees rated 4 or 3 must be removed in future.

Trained Inspectors. Inspectors should attend a Forest Pest Management training course (preferably Hazard Tree Recognition and Recreation Oriented Pest Management), have on-the-ground experience in the hazards peculiar to their District's forest stand and site conditions, and take periodic refresher courses.

If requested, Forest Pest Management will assist the District in setting up a tree hazard evaluation program.

MANAGE THE VEGETATION

Hazard tree treatment addresses the immediate problem of safety, but it does not address the long-range difficulty of managing a stand that is predominantly old-growth and decadent. A vegetation management plan is needed to describe the vegetation management goals, type of stand that is desired, and how it will be achieved and maintained. This plan should also consider how the pests reported here will affect attainment. The following discusses the major disease pests and how their management will affect existing vegetation and plantings.

Annosus Root Disease

Although much of the stand is old-growth true fir, there are some groups of younger-growth firs that will respond to thinning. Maintain stocking at levels that permit annual height growth of one foot or more to reduce losses to annosus in these infected stands.

In openings caused by mortality from annosus decay, plant a mixture of pine and true firs or pines alone. The pines are generally not susceptible to annosus attack from true fir stumps; some firs will succumb to annosus, but most will withstand infection once they attain rapid growth. Most hardwoods are resistant to annosus and, if suitable to the site, may be planted in infection centers.

While removing hazard and diseased trees, avoid injury to the residual stand; basal wounds are an important entry point for annosus decay. Treat all conifer stumps with borax to minimize new annosus infection (FSM 2305 and 2331.33, R-5 Supplement No. 90).

Fir Engravers and Borers

No insect activity was observed at the time of this evaluation, but the presence of several disease agents suggests that insects could attack firs in the future. The principal insect pests in true firs are the fir engraver (Scolytus ventralis) and the roundheaded fir borer (Tetropium abietis). Attacks by fir engravers and borers are usually associated with overstocking, drought, dwarf mistletoe infection, or root disease, and may be prevented by silvicultural treatments that create and maintain healthy, vigorous stands. Direct control is usually not feasible because of the number and variety of breeding sites available under forest conditions.

True Fir Dwarf Mistletoes

The infected fir overstory is a threat to fir regeneration. To reduce this threat, remove all infected overstory from areas to be planted with fir, or, if that is not possible, plant with pine or hardwoods. Note that dwarf mistletoes from red and white fir will not cross-infect the other fir species; hence, an infected overstory of one species may remain in place over a plantation of the other species.

In pole size and smaller stands of infected fir, thin to promote rapid growth; height growth of a foot or more per year will allow a fir to outgrow the upward spread of the mistletoe. Pruning dwarf mistletoe from true firs is not recommended.

Yellow Witches' Broom

Removing infected overstory will probably have no effect on the severity of disease. When thinning infected, young-growth stands, select against firs with infection and, if desired, prune infected branches from the residuals.

For maximum benefit to the public, we recommend that the District, working with the permittee, carry out the three action alternatives. Integrating these alternatives is the best method to ensure the health and safety of visitors to Quaker Meadow Camp, and to create and perpetuate an attractive and healthy forest stand.

TREE HAZARD REFERENCES

- Mills, Lynn J., and Russell, Kenelm. 1980. Detection and correction of hazard trees in Washington's recreation areas. State of Washington, Department of Natural Resources, DNR Report No. 42. 37 pp.
- Paine, Lee A. 1971. Accident hazard: evaluation and control decisions on forested recreation sites. U. S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Research Paper PSW-68. 11 pp.
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- Wallis, G. W., Morrison, D. J., and Ross, D. W. 1980. Tree hazards in recreation sites in British Columbia: management guidelines. British Columbia Ministry of Land, Parks, and Housing, and Canadian Forestry Service, Joint Report No. 13. 52 pp.

PEST BIOLOGY

ANNOSUS ROOT DISEASE

Fomes annosus is a fungus that attacks most conifers, decaying the heartwood and killing the sapwood and cambium. Pacific madrone and manzanita are the only hardwoods known to be infected. The fungus can spread long distances above ground by air-borne spores; these are produced by fruiting bodies (conks) that develop in decayed stumps, under the bark of dead trees, or under the duff at the root collar. The spores land on freshly-cut stump surfaces or on wounds in living trees, where they germinate and infect the new host.

Once established in a stump or tree, the fungus grows into and through the host roots until it contacts the roots of adjacent trees, which it then infects. In this way, F. annosus spreads from stumps or dead trees into the roots of living trees in an enlarging infection center. The fungus may spread underground into adjacent fresh stumps or recently-dead trees, but only if they are not already decayed by other fungi. F. annosus can remain viable in infected roots or stumps for 50 years or more. Infection centers usually enlarge until the fungus reaches natural barriers such as openings or groups of non-host plants. Young conifers established within infection centers often die shortly after their roots contact infected roots in the soil.

The fungus kills pines relatively quickly without causing extensive decay. It spreads through the inner bark and sapwood of the root system, killing these tissues; within 2-6 years it reaches the root crown and girdles the tree. By contrast, true firs are seldom killed directly. The fungus spreads into the heartwood and inner sapwood of the larger roots, and then into the lower bole of the host, where it causes a butt rot. Vigor and volume are reduced, but death is usually the result of windthrow or insect attack. Healthy young firs are usually able to produce roots faster than the fungus can decay them, but older, slower-growing firs gradually decline because of root loss. This decline may take 10 to 20 years before a tree dies.

Generally, firs growing within pine disease centers are highly susceptible to annosus infection, while pines adjacent to infected fir stumps usually escape attack. Thus large fir infection centers can be revegetated by planting pines.

FIR ENGRAVER

The fir engraver (Scolytus ventralis) attacks both white and red fir in California. Trees ranging in size from large saplings to overmature sawtimber are susceptible. Attacks can cause patch-killing of cambium along the bole, top-kill, or death of the tree. Top-kill and death are often associated with firs that have been weakened by root disease, severe dwarf mistletoe infection, overstocking, soil compaction, sun-scald, logging injury, or drought. The fir engraver also breeds in slash and windthrown trees.

The fir engraver usually completes its life cycle in one year, sometimes two. Adults fly and bore into trees or green fir slash from June to September; larvae, pupae, and adults overwinter under the bark. Pitch tubes are not formed as they are with pine bark beetles; the usual evidence of attack is boring dust in bark crevices along the trunk and pitch streamers on the mid and upper bole. Trees colonized early in the summer may begin to fade by early fall, but trees attacked later in the year usually do not fade until the following spring or summer, often after the beetles have emerged.

INDIAN PAINT FUNGUS

Echinodontium tinctorium causes a yellow-brown stringy rot of true firs and hemlock, and is the most serious heartrot organism of these species. It rarely attacks Douglas-fir. The fungus usually enters trees through dead branches, but may also enter through trunk scars, dead tops, and other wounds. As a result, the rot is most common in mid-stem, but may also extend into the butt or down from the top. Trees younger than 40 years are essentially free of decay because of limited heartwood development.

Fruiting bodies (conks) on the trunk at knots or branch stubs indicate decay. The woody, perennial conks are hoof-shaped, rough and blackish on top, grayish and toothed or spiny underneath. The interior is a distinctive rust or brick red color, and was used by Indians as a pigment. Generally, heartrot extends 16 feet above and below a conk. The larger and more numerous the conks, the greater the decay. The presence of conks larger than six inches across and separated by 10 feet or more vertically indicates extensive decay.

The decay is restricted to the heartwood and may not always affect the entire cross-section of the heartwood column. The degree of weakening depends upon the width of the sapwood, which is governed chiefly by the tree's diameter growth rate.

ROUNDHEADED FIR BORER

The roundheaded fir borer (Tetropium abietis) infests true firs throughout California. It will kill weakened trees, often in combination with S. ventralis, but it is not reported as becoming epidemic. The life cycle is one year. Larvae mainly bore between the bark and wood, although they may cause timber degrade by boring into the wood to pupate.

TRUE FIR DWARF MISTLETOES

Arceuthobium abietinum is the only dwarf mistletoe species that has two host-specific forms. One infects only white fir and grand fir, and the other infects only red fir and noble fir. Pines are not susceptible.

Dwarf mistletoes are flowering plants that require a living host, from which they obtain most of their nutrients and all of their minerals and

water. They spread by means of sticky seeds that are forcibly discharged from the plants in the fall and adhere to whatever they contact. If a seed lands on a host needle or twig, it remains there over winter; the following spring it germinates, and the radicle penetrates the host. The parasite develops a root-like endophytic system in the inner bark and outer sapwood, and produces aerial shoots within 2-4 years after initial infection. On true firs, another 3-5 years elapse before seed are produced.

The spread of dwarf mistletoe is limited to the distance travelled by the seed, which from overstory to understory is usually 20 to 60 feet; with the aid of wind, the seed may be carried as far as 100 feet. A rule of thumb is that dwarf mistletoes can spread a horizontal distance equal to the height of the plants in an infected tree. Because of the long life cycle and the various limits to spread, the actual spread rate through an even-aged stand is usually 1-2 feet per year. Vertical spread in true fir is limited by the density of the crown; on the average, the parasite moves upward about three inches per year.

Unlike western dwarf mistletoe (*A. campylopodum*), which infects ponderosa and Jeffrey pines, true fir dwarf mistletoes seldom produce large brooms. They do, however, cause large swellings in the stems of long-infected firs. These swellings may grow to twice the normal diameter of the stem, and often are extensively decayed and prone to breakage.

YELLOW WITCHES' BROOM

Yellow witches' broom is caused by a rust fungus, *Melampsorella caryophyllacearum*. The principal aecial hosts are white fir and red fir of all ages; the alternate or telial hosts are species of chickweed. In California the disease is never common, but most often found on red fir in the central and southern Sierra Nevada. The rust usually causes branch brooms and, less frequently, trunk burls or spike tops. It is seldom serious, but multiple brooms can reduce growth, provide infection courts for decay fungi, and even kill seedlings, saplings, and occasionally larger trees.

M. caryophyllacearum has a life cycle typical of macrocyclic rusts, alternating between its true fir and chickweed hosts. The fungus is systemic and perennial on both true firs and on those chickweed species that are perennial. The severity of fir broom rust is related to changes in abundance of its chickweed hosts, and to seasonal, climatic variations.

The rust causes its conifer hosts to produce upright, compact witches' brooms with a dense growth of small, shortened branches and short, thick needles. In mid-summer to fall, the brooms take on a yellowish-orange color, partly as a result of aecia production. The needles darken, die, and drop from the branches in late fall, and the brooms are bare until the following spring, when yellowish-green new needles are produced.

QUAKER MEADOW CAMP -- West Half

Tule River Ranger District
Sequoia National Forest



Figure 1. Hazard Trees and Disease Pests at Quaker Meadow Camp (West Half), Tule River Ranger District, Sequoia National Forest, 1984.

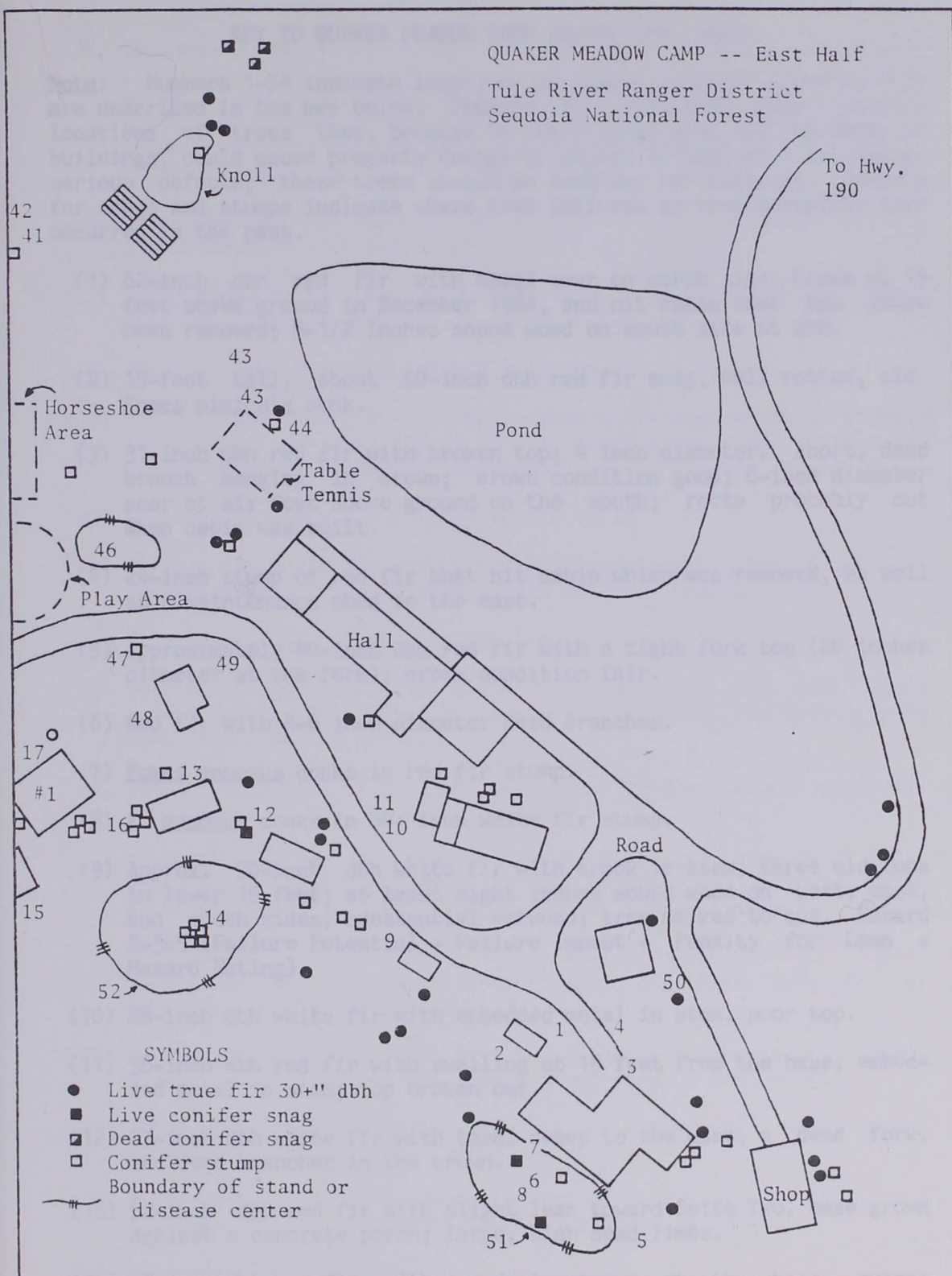


Figure 2. Hazard Trees and Disease Pests at Quaker Meadow Camp (East Half), Tule River Ranger District, Sequoia National Forest, 1984.

KEY TO QUAKER MEADOW CAMP HAZARD TREE MAPS

Note: Numbers 1-54 indicate locations of trees or groups of trees that are described in the key below. Symbols for live true firs indicate locations of trees that, because of their large size and proximity to buildings, could cause property damage or injury if they were to develop serious defects; these trees should be examined periodically. Symbols for snags and stumps indicate where tree failures or tree mortality have occurred in the past.

- (1) 62-inch dbh red fir with basal scar on north side; broke at 15 feet above ground in December 1982, and hit cabin that has since been removed; 5-1/2 inches sound wood on south side at dbh.
- (2) 15-foot tall, about 50-inch dbh red fir snag, well rotted, old Fomes pinicola conk.
- (3) 31-inch dbh red fir with broken top; 4 inch diameter, short, dead branch hanging in crown; crown condition good; 6-inch diameter scar at six feet above ground on the south; roots probably cut when cabin was built.
- (4) 24-inch stump of red fir that hit cabin which was removed, as well as a maintenance shed to the east.
- (5) Approximately 40-inch dbh red fir with a tight fork top (20 inches diameter at the fork); crown condition fair.
- (6) Red fir with 4-6 inch diameter dead branches.
- (7) Fomes annosus conks in red fir stump.
- (8) F. annosus conks in 80+ inch white fir stump.
- (9) Approx. 30-inch dbh white fir with crook in stem, three old tops in lower 15 feet; at least eight inches sound wood on west, east, and south sides, substantial wetwood; tree marked to cut. Hazard $2+3=5$ (Failure Potential + Failure Impact + Penalty for Lean = Hazard Rating).
- (10) 28-inch dbh white fir with embedded metal in stem, poor top.
- (11) 38-inch dbh red fir with swelling at 15 feet from the base, embedded metal in stem; top broken out.
- (12) 27-inch dbh white fir with basal sweep to the east, a dead fork, and dead branches in the crown.
- (13) 52-inch dbh red fir with slight lean toward Suite Two, base grown against a concrete porch; large, high dead limbs.
- (14) 45-inch dbh red fir, with several stumps at the base, sweeps toward north-northeast (Cabin-Store); possible E. annosus; Armillaria mellea present.

- (15) 32-inch dbh white fir, with a partially open wound on the north from its base to 45 feet, one foot to 2-1/2 feet wide; at breast height, tree is solid at wound on north, 12 inches wood on the south, 10+ inches sound on the west; crown condition poor. Decay present in open wound at base (borer goes in at least 12 inches). Hazard 2+3=5.
- (16) Three 30-35 inch dbh red firs exposed by windfalls and removals; crowns only on 1/2-to-1/3 of a side, tops are flat.
- (17) 24-inch dbh white fir with old fork, one stem still alive; possible decay at fork.
- (18) 40+ inch true fir stump with F. annosus and A. mellea.
- (19) 25-inch dbh red fir with basal opening (through adjacent stump); thin crown, open swelling at 15 feet above ground on the south-east. Hazard 1(2)+3=4(5) (marginal).
- (20) 56-inch dbh white fir leaning toward north.
- (21) 35-inch dbh white fir with three Echinodontium tinctorium conks at 30 feet above ground on side toward toilet. Hazard 2+3=5.
- (22) 31-inch dbh red fir with broken top.
- (23) 49-inch dbh white fir with tight fork, bulge at 10 feet above ground; fork to west swept toward Cabin Three; 15+ inches solid wood at dbh on the north.
- (24) 33-inch dbh white fir with top out, sparse crown, epicormic branching.
- (25) 40-inch dbh red fir with 1 to 1-1/2 foot scar on north at eight feet, F. annosus in old stump at base on northwest; 5 inches sound wood at dbh on north, 10 inches exactly on the south. Hazard 3+2=5.
- (26) 31-inch dbh white fir with sweep to west, old dead fork in top partially healed; no hazard (1+2=3).
- (27) 35-inch dbh white fir with scar and bulge on southeast, all wounds closed, some bleeding; 13+ inches sound wood on southeast.
- (28) Three 20-30 inch dbh white firs in a group, all with ragged crowns.
- (29) F. annosus in white fir stump in area of five stumps -- four white fir, one red fir (with old Ganoderma oregonense conk).
- (30) F. annosus in fir stump.

- (31) 35-inch dbh red fir with large dead branches in crown over archery area (tree is 165 feet tall).
- (32) 38-inch dbh white fir leaning slightly toward campfire circle.
- (33) Approximately 40-inch dbh white fir leaning toward volleyball court; bulge at 20 feet above ground on the west side.
- (34) 37-inch dbh white fir leaning substantially toward chapel, partially corrected in upper crown. E. annosus in stump on the north; 12+ inches sound wood on north at two feet above ground; 6+ and 8+ inches sound wood in two roots on north side on either side of the stump. Hazard $2+3+1=6$.
- (35) Six 30+ inch dbh white firs in a group.
- (36) 37-inch dbh white fir with thinning crown, long dying branches.
- (37) 26-inch dbh red fir with wide double top, possible decay at a likely third top in the middle; crown condition good.
- (38) 11-inch dbh white fir with yellow witch's broom rust (caused by Melampsorella caryophyllacearum) in upper one-third of its crown, and dwarf mistletoe (Arceuthobium abietinum).
- (39) 50-inch dbh red fir, crown thinning, dead branches, dwarf mistletoe rating of 5, top dead.
- (40) 44-inch dbh white fir with a crook at its base, leaning toward the horseshoe area.
- (41) 48-inch dbh red fir with dwarf mistletoe rating of 5, no crown on the west side, and large dead branches.
- (42) 55-inch dbh white fir with dwarf mistletoe, multiple tops, lean toward southeast, and two E. tinctorum conks at fifteen feet above ground on the north side. Hazard $3+2+1=6$.
- (43) 30+ inch dbh white fir with thin, ragged crown, several hanging dead branches.
- (44) 28-inch dbh white fir with crook leaning out over table tennis area.
- (45) 56-inch dbh white fir with many dead branches over the play area.
- (46) Overstocked group of two-to-eight inch dbh red fir saplings with witch's broom rust (M. caryophyllacearum); possibly thin selectively to promote growth.
- (47) 48-inch dbh red fir snag that broke at about 82 feet above ground.
- (48) 22-inch dbh white fir with dwarf mistletoe canker on the southeast at eight feet above ground (on the side toward the mail room);

tree bole back-filled with soil to about three feet above base on the southeast.

- (49) Group of two 30+ inch dbh red firs, two 30+ inch dbh white firs, and two smaller conifers; trees lean outward from each other, crowns sparse on the inside of the group, crowded, with some dead branches.
- (50) Approximately 65-inch dbh white fir double tree, thin crown, roots close to the road, bleeding at its base, dead branches in crown; lower fork is oriented east-west, tight with bulges at base; higher tight fork on the eastern of the two major stems is oriented northeast-to-southeast (each stem is about 18 inches in diameter just above the highest fork).
- (51) An opening in the stand that is suspected of being a root disease center because of the number of stumps and the presence of Fomes annosus conks in two of them.
- (52) Several wind-thrown firs scattered throughout this site, which is filled with large boulders; possible root disease center, but not confirmed.
- (53) Large red and white firs in this area, some of which have large dead branches high in their crowns.
- (54) Old-growth red and white fir stand, with sapling- to pole-size fir understory. E. annosus present in most large stumps. Dwarf mistletoe extensive in the overstory, dwarf mistletoe and broom rust prevalent in the understory. Dense patches of fir reproduction scattered throughout this area, although reproduction is generally absent elsewhere.